RAILWAY ENGINEERING
and Maintenance of Way

Published by the
BRUCE V. CRANDALL COMPANY, CHICAGO

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Cincinnati Office: 314 Mercantile Library Building
Telephone - - 4216 Main

A Monthly Railway Journal

Devoted to the interests of railway engineering, maintenance of way, bridges and buildings.

Communications on any topic suitable to our columns are solicited.

Subscription price, $1.00 a year; to foreign countries, $1.50, free of postage. Single copies, 10 cents. Advertising rates given on application to the office, by mail or in person.

In remitting make all checks payable to the Bruce V. Crandall Company.

Papers should reach subscribers by the tenth of the month at the latest. Kindly notify us at once of any delay or failure to receive any issue and another copy will be very gladly sent.

Entered as Second-Class Matter April 13, 1905, at the Post Office at Chicago, Illinois, Under the Act of Congress of March 3, 1879.

VOL. II CHICAGO, SEPTEMBER 1906 No. 9

Railroading as a Life Work

ALONG this line we wish to quote a few words from a paper delivered before the Richmond Railroad Club of Richmond, Va., by Mr. W. D. Duke, assistant to president R. F. & P. & W. S. Ry.

"There is perhaps no single calling that combines so many rare qualifications as must be possessed by the well-rounded railroad man. * * * Lord Bacon said, 'There be three things which make a nation great and prosperous; a fertile soil, busy workshops, and easy conveyance for man and goods from place' * * * * * If you would make a success of your business, do not be satisfied to perform merely the duty that is assigned to you by your immediate superior, or to follow the example of the vast army of men who are content with mediocrity. The ambitious man will study the interests of his employer as if they were his own, and when the opportunity for advancement comes he will be qualified to assume increased responsibility. The railroads are constantly on the lookout for men who can do things better than the average man can do them, and prefer to promote in the service rather than to employ men who have received their training elsewhere. Be sure that, when called upon to fill a more important position you will be qualified to fill it. 'He is not fit to command who has not first learned to obey.' How often just such articles or advice is passed over in a hurry by the average or mediocre man. With a thought that it's just some more 'talk' it is passed up. If a two or three months' spurt does not produce an actual ten or fifteen dollar raise in salary, the young man is immediately discouraged and drops back into his old habits. Not only do the 'practical' men get this way but great numbers of the college-trained young men soon fall into disrepute. The type of railroad man that believes there is always something new that he can learn is the kind most likely to advance. Whether his information comes from the section man, round house hostler or from his own superior, it will come in to help him when he least suspects."

Air Resistance of Electric Railways

THE results of the Electric Railway Test Commission on Air Resistance of Electric Railway which have been discussed on another page of this issue, are quite valuable. They have served to demonstrate this fact, that electric roads are not getting as good work out of their cars as they may be able to by the use of a different shaped vestibule both front and end. In these most carefully conducted tests the fact that a power of 467 kilowatts was needed to overcome the air resistance of the ordinary vestibule, while 175 kilowatts accomplished the same work with the parabolic form of vestibule is conclusive. Another important point gained was the knowledge that comparatively, the air resistances on the surface of the car body are small as against the head and rear ends. It seems that these points have been made use of in Germany for several years and is one of the few things we must concede their work to be ahead of ours.

Maintenance of Way Expenditures

MAINTENANCE of Way expenditures are all more or less supposed to either decrease operating expenses or to facilitate traffic by some means or other. Whether it be the renewal of ties or ballast to secure a better riding track and the consequent increased speed of trains or the painting of station buildings, it is all supposed to be returned as many fold as possible. The maintenance of way engineer is therefore consequently always on watch to devise some method of further decreasing operating expenses. His department is in that respect the "watch dog" of the operating department. Hence it would seem that the engineer must be a good economist in the strongest sense of the term—the practical one. Indeed nearly everything that he desires to have changed or any new work to be done, must be accompanied by a thorough explanation of the subsequent advantage to follow. He knows by constant experiments of this kind very nearly what his general superintendent or general manager will allow.

There is one state of affairs however, about which he

can make no estimate, the elevation or depression of tracks in cities to avoid grade crossings. Statistics are valuable in many ways. We can follow them through many different periods of this country and note the actions of certain roads in them and with a degree of certainty we can look for similar action later in a like period. When it comes to estimating the probable saving of life by the eliminating of a grade crossing at a certain street, we are at sea. It would be foolish to even attempt to figure on it. The saving in time with an elevated track is easily demonstrated and a clear and unobstructed right of way is worth lots of money to the road having any appreciable amount of traffic. To the man however, who figures the dollars and cents so closely, it seems like sinking the money in some hole. After it is all in and trains running again in good order, he wonders how they ever got along before without it.

Sulphur Method of Treating Ties

THE processes of treating wood to increase its future life are of importance in view of the rapidly decreasing variable supply of wood for railroad ties. A new method by the use of sulphur may prove of interest to some of our readers. This method in question has been recently patented in Germany and its practical application will be watched with interest.

Sulphur is applied in liquid form, and in hardening completely fills up the interstices of the woody fibre. The following gives a detailed statement of the process: Sulphur is fused in a befitting receptacle, making use of steam to avoid an excess of heat, which deteriorates the sulphur. Into this liquid, and at a temperature of about 140°, are steeped the boards which are to receive the treatment, care being taken to immerse them completely. The foam which gathers at first, called forth by the separation from the wood of the air and humidity it contains, disappears at the moment the wood thoroughly assimilates the temperature of the bath, which is then lowered to 110°. At this point the sulphur becomes hard and, while the air contracts itself, the sulphur penetrates into the fibrous tissues, propelled by atmospheric pressure. The boards are then slowly withdrawn from the bath allowing a thin and even coat of sulphur to form and cover the wood, as any superfluous surcharge can be removed only with the greatest difficulties afterwards. This coat of sulphur has a vitreous appearance and forms a very tenacious crust, excluding all tendencies to chip or break.

The degree to which wood is impregnated varies according to the nature of the wood, the temperature and the duration of the bath. It may be gauged by the increase in weight of the boards which amounts to from 30 to 35 per cent. where the process is conducted in an open receptacle, and to 100 per cent. if in a vacuum pan. Theoretically it may be said that a complete fullness of the pores of the wood would increase its weight by 200 per cent. In numerous experiments poplar was the best wood to take the sulphur treatment. Oak and pine wood do not admit of the process quite so favorably, because their dry distillation begins at 140°, which can be proved simply by observing that while the wood is immersed in the bath bubbles are continually rising, marking the escape of volatile substances. Moreover the resin blackens the sulphur. The process up to date has been applied only to thin boards, but in view of the satisfactory results the hope is entertained of its becoming very popular.

Some of our roads are very much alive to the tie question today and much more so in the west. Here one large system has several large treating plants already in operation. Then we read that the delivery of 1,500,000 ties ordered by E. H. Harriman from Japan, has commenced in the landing at Guaymas, Mexico, of one ship load of 8,300. These ties cost, delivered in Mexico, fifty six cents each in gold. The price paid does not indicate the pressure railroads labor under in maintaining not a reserve, but a sufficient number of ties to provide for actual needs of the service. This action on the part of Mr. Harriman has brought a new phase into the tie question and it has caused considerable comment.

Permanent Railway Construction

ALONG the line of "permanent" railway construction in the first layout of the road, the work to be undertaken shortly by the Western Pacific Railway Company is very noteworthy. Instructions to the engineers in charge have been to put their line through as straight and with the least grades possible. If similar instructions had been given to engineers who laid out some of our largest trunk lines, what a blessing it would have been to the operating officials. A straight track with comparative grade—what a saving would that not bring about? However, it is not for our generation to be critical, for who thirty or forty years ago, could have predicted the vast railway systems that today operate throughout the country. Here, in short, is what the Western Pacific is proposing to do: To bore some forty-five tunnels in eastern California, between Oroville and Beckwith Pass. The longest of the tunnels is that at the head of Spring Garden, twelve miles east of Quincy. This is to be cut under the ridge dividing the north and middle forks of the Feather river. When completed it will be over 7,000 feet in length. The next longest tunnel on the road will be the one under Beckwith Pass. This will be over 4,000 feet in length and will be bored from both ends. The third tunnel will probably call for the most skillful engineering feat of all, as it will be cut through solid rock for a distance of 1,200 feet. This will be north of Quincy, on Spanish Creek. Such an undertaking is without a doubt expensive in the extreme, but will pay for itself in not such a far distant period as many western roads would no doubt be willing to testify. With this feat accomplished the Gould transcontinental line will no longer be a dream, but a living reality.

*Heating, Ventilating and Air Washing Equipment of the L. & N. Depot, Louisville, Ky.**

THE installation of an indirect heating and ventilating system recently completed in the new Louisville & Nashville depot at Louisville, Ky., is of unusual interest because of of its novel features peculiarly adapting it to the work. The desirability of a capable ventilating plant to insure a good supply of fresh clean air will not be questioned—for the Louisville depot is not unlike other stations which find themselves congested with people of all classes who have a wide diversity of opinions concerning personal cleanliness. It may be of interest to those not familiar with the old L. & N. depot, to know that the exterior architectural design of the new building was almost in exact duplicate of the old structure, which was destroyed by fire not long ago.

At the time of the completion of the installation, the apparatus was given a thorough test and was accepted by the engineers for the L. & N. R. R. Co. However, it has not been installed for a sufficient length of time to have undergone a thorough practical "endurance" test whose good reports have much weight. The system is unique because of the installation of an Air Washer to supplement the ventilation and assure quality as well as quantity of the air. The need of some sort of filter was appreciated by the engineers and the washer chosen was selected because it was entirely automatic in operation, self cleansing and occupied but little space. Other types of cheese cloth and coke screens were not found adaptable for the above reasons.

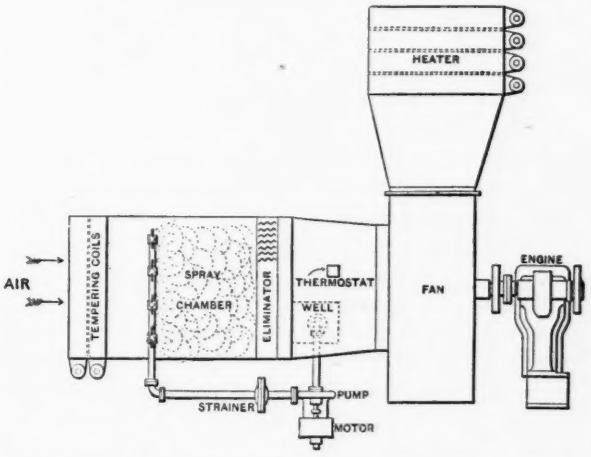
The washing effectually removes all solid matter in suspension and undesirable gases such as would necessarily be present in the vicinity of a large railroad station. After the air has been washed the free moisture is removed as will be later explained. The scheme incorporated in the design of this feature of the washer is such that the air is allowed to retain only such portion of the moisture introduced as will be correct to maintain the humidity of the air at the proper point. It is further explained how the humidity is automatically controlled through the agency of a thermostat which is in itself an interesting feature.

The air inlet to the ventilation system is through an air shaft 3′ 6″x6′ 9″ running to the top of the building. The air then passes one two row and two four row tempering coils 7′x8′ 4″ and containing 2,400 feet of 1″ pipe, which serves to heat the incoming air in cold weather to 50 or 60 degrees before it passes on to the Air Washer. From the washer it passes divided, *each* portion passing through a set of heating coils containing 4,050 feet of 1″ pipe—then each portion continues on its own separate path passing through a 100″ three-quarter housing blower which is 71″ wide. The discharge of each fan passes through its next heater coil of 1.440 feet of 1″ pipe and into a Plenum Chamber from whence it is led by galvanized iron ducts to the many diffusers placed around the building. Many of the main ducts in the basement were not injured by the fire and Joseph McWilliams & Co., the contractors and engineers for the new work, had much difficulty in contending with the poor engineering on the original installation which was very poorly laid out by other contractors.

All the new heating and tempering coils were tested on the grounds after shipment in addition to the factory test in which they must show no leaks at 150 lbs. hydraulic pressure. This was to discover any leaks which might have occurred due to handling in shipment. The coils were covered by a casing of No. 12 galvanized iron securely braced and stayed throughout with angle and tee iron.

AIR CLEANSING.

Owing to the quantity of cinders, soot and foul gases present in the atmosphere it was found desirable to provide means of removing such. Previous to the introduction of the air to the ventilating system it must be passed through some sort of filter to cleanse it. This provision was made by the installation of an Air Washer and Humidifier. This they deemed would be more practical than the usual type of coke screens or cloth filters,—both as far as thoroughness in performing the work to be done, space occupied and in regard to the first cost of installation and also maintenance expense. The coke screens and in particular the cloth filters have been found



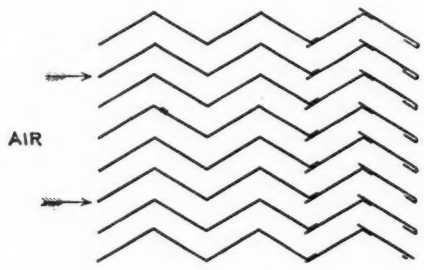
BUFFALO AIR WASHER AND HUMIDIFIER SHOWING RELATIVE POSITION OF NOZZLES, ELIMINATOR, ETC.

*By Richard C. Williams, M. E., with Buffalo Forge Co., Buffalo, N. Y.

in practice to require frequent renewal and an annoying amount of attendance by the busy janitors of buildings where installed—though they make a very attractive proposition on paper.

The selection and installation of the Buffalo Air Washer included the solution of the problem of having the air supplied for ventilation at the proper point of humidity. Not until the last few years has the fact been appreciated by most engineers that the humidity plays as important a part in the sensations to a person's body in that atmosphere as does the temperatures shown by the thermometer. The conditions which are normal to the body are from 50 to 75 per cent. relative humidity—i. e.—the air must hold from 50 to 75 per cent. of the moisture that it could if saturated at that particular temperature. If the humidity is outside these limits peculiar sensations are experienced, either of dryness, or of "mugginess" as it is sometimes called, the one being a lack of moisture in the air and the other is caused by an excess, which does not allow enough evaporation from the body to keep it comfortable.

The Air Washer provides for keeping the relative humidity at a constant percentage of the saturated point



DIAGRAMETIC SKETCH OF ELIMINATOR PLATES

irrespective of the air drawn in through the grating. When the temperature of the outside air is below 70 degrees the air drawn in next passes the tempering coils which serve to raise its temperature to between 70 and 80 degrees F., whence it proceeds to the washing device. The washing is accomplished by sprays of water atomized from 171 specially designed nozzles, placed in a sectional area of conduit of 7 feet 10 inches wide by 9 feet high, in which the atomizing action is obtained by a rotative action given the water by its path through the nozzle. So successful is this method that the spray is barely visible. The projection of the water is in the direction of air travel, so that completeness of washing is assured with varying velocities of the air. The water is supplied to the nozzles by a 1½ inch brass belt driven centrifugal pump. It may be interesting to note that as each nozzle delivers about 1½ pounds of water per minute—about 250 lbs. of water per minute or over seven tons during an hour are used to wet down the entering air. Economy in the use of this water will be explained later.

The air then comes in contact with the Eliminator, as it is termed, an essential feature of the outfit, consisting of a system of vertical baffle plates so arranged and designed as to be capable of removing all the free moisture from the passing air, and yet allowing it to retain an approved amount, sufficient to the proper regulation of the humidity. The first portion of the baffle plates presents to the air merely a water film, contact with which effectually removes every trace of solid matter that may have been present originally in the air. The second portion of the plates include gutters running the length of the plates to prevent the water being blown from the farther edge by the velocity of the air. These break the continuity of the water film on the first portion and serve to remove the free moisture. By test it has been found that the resulting back pressure caused by the interposition of these baffle plates is less than one tenth of one inch water pressure. To prevent the possibility of rust, these baffle plates are made of galvanized iron, and are therefore noncorroding though sometimes at preference expressed by the purchasers copper has been used. The water from the gutters in the baffle plates runs to a settling tank built in the concrete foundation for the Washer, and on which the Washer is supported on galvanized I. beams. The cleaner water is drawn to a well with which the suction of the pump supplying the nozzles is connected and hence the water used over and over again till all evaporated—the level in the settling tank is, however, maintained constant by means of a float valve. All water passing the pump is passed through a strainer before being returned to the nozzle—though the nozzles are readily taken apart by hand to remove any scum or deposit that may collect there.

A thermostat is placed between the baffle plates and the blower which is adjusted by trial till it allows the proper percentage of humidity, which it will then automatically maintain. The action of the thermostat is to regulate the temperature of the spraying water, when the temperature between the fan and the eliminator plates changes. This method of regulation was adopted after experiments showing that the amount of moisture absorbed by the air was dependent more on the temperature of the spray water than upon the temperature of the air. The control of the water temperature is through a steam jet, connected with the thermostatic motor.

The Washer and Eliminator are neatly housed in heavy galvanized iron, stiffly braced, riveted and soldered to be watertight. There is provision for a door with a watertight gasket and a panel is arranged for a plate glass window to allow inspection of the Washer during operation.

Another serviceable and by no means to be forgotten use of the Washer during the summer months, is to cool the air admitted to the building. This capacity it is guaranteed that the final temperature difference between the spray water and air will not exceed 20 per cent of the initial difference of temperature, when considered at the rated capacity of the Washer.

The Heating and Tempering Coils, Air Washer and Humidifier, etc., were furnished by the Buffalo Forge Co., of Buffalo, N. Y.

Comparative Value of Cross-Ties of Different Materials*

By W. C. Cushing,
Chief Engineer of Maintenance of Way, Pennsylvania Lines West of Pittsburg, S. W. System.

HAVING been approached from time to time by the inventors of different designs of concrete and steel cross-ties, the writer found it necessary to make an investigation, with a view to determining, as closely as possible the relative value of such cross-ties, taking cost and prospective life into account, as compared with the wooden cross-ties at present in use. It seemed to him that the article by Mr. S. Whinery, on page 37 of the Railroad Gazette for November 11, 1904, furnished the best plan for this study, and, accordingly, the accompanying tables have been derived from Mr. Whinery's formulas.

Some of the data used are costs established from actual practice and from reliable information given, while in other cases assumptions have been made after examining the most reliable information available. It is quite true, of course, that these figures cannot be considered as absolutely correct, but it is believed by the writer that they are fairly trustworthy.

Table I. Showing cost delivered which a white oak tie, lasting 10 years, must reach before it will be economical to use any of the ties heading the columns of table.

Line	Letter of formula	Description	White Oak untreated	Inferior Woods No tie plates		Inferior Woods with Tie Plates					Steel Casting		Concrete Casting	
				Zinc chloride	Zinc tannin	Zinc chloride	Zinc tannin	Zinc creosote	Creosote costing .30	Creosote costing .85	1.75	2.50	1.50	2.25
1		Assumed life of tie	10	10	10	12	14	16	16	30	20	30	20	30
2	i	Assumed rate of interest	4	4	4	4	4	4	4	4	4	4	4	4
3	S	Annual Pay't for renewal of tie	.0833	.0833	.0833	.0665	.0547	.0458	.0458	.0178	.0336	.0178	.0336	.0178
4		Spacing of ties C to C in feet	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833
5		Assumed cost of tie delivered	$	$ .46	.46	.46	.46	.45	$ .46	$ .46	$ 1.75	$ 2.50	$ 1.50	$ 2.25
6		Cost of treating tie		.15	.18	.15	.18	.27	.30	.85				
7		" " switching & foreign freight		.07	.07	.07	.07	.07	.07	.07	.06	.06		
8		" " putting in tie	.12	.12	.12	.12	.12	.12	.12	.12	.15	.15	.15	.15
9		" " 4 track spikes	.064	.064	.064									
10		" " 4 bolts									.10	.10	.16	.16
11		" " 4 wood screws				.15	.15	.16	.15	.15				
12		" " 4 helical linings				.03	.03	.03	.03	.03				
13		" " 2 tie plates				.32	.32	.32	.32	.32				
14		" " application of fastenings	.03	.03	.03	.12	.12	.12	.12	.12	.07	.07	.07	.07
15		Total cost of tie in track		.894	.924	1.42	1.45	1.54	1.57	2.12	2.13	2.88	1.88	2.63
16	C	Cost of ties per lin foot of track		.489	.504	.775	.791	.840	.856	1.156	1.162	1.571	1.026	1.435
17	V	Value of old tie per lin ft of track									.40	.40		
18	X	Annual cost of ties per lin ft track		.06017	.0621	.0825	.0749	.0721	.0734	.0668	.0721	.0837	.0755	.0829
19		" " " " " Mile "		317.70	327.89	435.60	395.47	380.69	387.55	352.70	380.69	441.93	398.64	437.71
20		COST DELIVERED WHICH A WHITE OAK TIE MUST REACH BEFORE IT WILL BE ECONOMICAL TO USE TIE AT HEAD OF COLUMN		.60	.71	1.01	.90	.86	.87	.78	.86	1.03	.91	1.02

Formulas $\begin{cases} z = C\,(i+s) \\ z = Ci + (C-V)s \end{cases}$

Seitz steel tie cost $2.50 delivered
Buhrer " " " 1.85 "
" concrete " " 2.56 in the track

W. C. Cushing
March 12, 1906

In connection with the tables, the following deductions have been made, and are presented to the members of the Association for their own consideration:

DEDUCTIONS FROM TABLE I.

(1) With white oak ties costing 70 cents delivered on the railroad, it is economical at the present time to buy inferior woods at a price not to exceed 50 cents, have them treated with zinc-chloride or zinc-tannin, lay them in the tracks without the use of tie-plates (except where it is necessary to use them on oak ties) and use a standard railroad spike. A life of ten (10) or eleven (11) years has been found to be a maximum for such ties without the use of tie-plates and better fastenings, and if the life of ten (10) years is not attained, there will be that much loss to the company.

(2) When a white oak tie reaches a cost of 86 cents or 87 cents delivered on the railroad, it will be economical to use the zinc-creosote process, or straight creosote costing 30 cents, if the tie costs 46 cents delivered on the railroad and will last sixteen (16) years; or, it will be economical to use straight creosoting costing 85 cents for treatment if the tie can be made to last thirty (30) years, which is French practice, before the oak tie reaches a cost of 80 cents delivered on the railroad. In both of these cases, it is assumed that tie-plates, wood screws and helical linings are used because ties cannot be made to last more than ten (10) or twelve (12) years without the use of proper fastenings, since, otherwise, the tie will be destroyed by mechanical wear. It is necessary, therefore, to use improved fastenings when we expect to

*From Bulletin issued by Am. Ry. Eng. and M. of W. Asso.

obtain a life of ties greater than ten (10) or eleven (11) years.

It will also be economical to use a steel tie costing $1.75 delivered, if it will last twenty (20) years.

(3) When the white oak tie reaches a cost of 90 cents delivered on the railroad, it will be economical to use either ties of inferior woods treated with zinc-tannin if a life of fourteen (14) years can be obtained, the improved fastenings being used; or a concrete tie costing $1.50 if it will last twenty (20) years.

(4) When the price of white oak ties reaches $1 it will be economical to use a steel tie costing $2.50 if it will last thirty (30) years, or an inferior wood tie treated with zinc-chloride if a life of twelve (12) years can be obtained.

(21) years in order to make them as economical as white oak ties costing 70 cents delivered.

(7) With inferior wood ties costing 46 cents delivered, and with the creosote treatment costing 85 cents as in French practice, it will be necessary for us to obtain a life of thirty-six (36) years from the ties in order to make them as economical as white oak ties costing 70 cents delivered.

(8) With steel ties costing $1.75 each delivered, it will be necessary for us to obtain a life of twenty-eight and one-half (28½) years in order to have them as economical as white oak ties costing 70 cents delivered. This price is a little less than the cost of the Buehrer steel ties in the tracks at Emsworth.

(9) With concrete ties costing $1.50 each delivered,

Table II. Showing how long ties of different materials must last in order to be as economical as white oak costing 70 cents and lasting 10 years.

Line	Letter of Formulae	Description	White Oak untreated	Inferior woods no tie plates: Zinc chloride	Inferior woods no tie plates: Zinc tannin	Inferior Woods with tie plates: Zinc chloride	Inferior Woods with tie plates: Zinc tannin	Inferior Woods with tie plates: Zinc creosote	Creosote costing .30	Creosote costing .85	Steel Costing 1.75	Steel Costing 2.50	Concrete Costing 1.50	Concrete Costing 2.25
1		LIFE WHICH TIE MUST HAVE IN YRS	10	9 3/16	10 1/16	18	18 1/2	20 1/4	21	36	28 1/2	Over 50	28 1/3	Over 50
2	i	Assumed rate of interest per cent	4	4	4	4	4	4	4	4	4	4	4	4
3	S	Annual Pay't for renewal (Kent, p16)	.0833	.0858	.0818	.0392	.0376	.0331	.0318	.0131	.0196	?	.0198	?
4		Spacing of ties CtoC in feet	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833
5		Assumed cost of tie delivered	$ .70	$ .46	$ .46	$ .46	$ .46	$ .46	$ .46	$ .46	$ 1.75	$ 2.50	$ 1.50	$ 2.25
6		Cost of treating tie		.15	.18	.15	.18	.27	.30	.85				
7		" " switching & foreign freight		.07	.07	.07	.07	.07	.07	.07	.06	.06		
8		" " putting in tie	.12	.12	.12	.12	.12	.12	.12	.12	.15	.15	.15	.15
9		" " 4 track spikes	.064	.064	.064									
10		" " 4 bolts									.10	.10	.16	.16
11		" " 4 wood screws				.15	.15	.15	.15	.15				
12		" " 4 helical linings				.03	.03	.03	.03	.03				
13		" " 2 tie plates				.32	.32	.32	.32	.32				
14		" " application of fastenings	.03	.03	.030	.12	.12	.12	.12	.12	.07	.07	.07	.07
15		Total cost of tie in track	.914	.894	.924	1.42	1.45	1.54	1.57	2.12	2.13	2.88	1.88	2.63
16	c	Cost of ties per lin ft of track	.498	.488	.504	.775	.791	.840	.856	1.156	1.162	1.571	1.026	1.435
17	v	Value of old tie per lin ft of Trk.									.40	.40		
18	x	Annual cost of ties per lin. ft. Trk.	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614
19		" " " " " Mile "	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19

Formulae { $x = C(i+S)$; $x = Ci + (C-V)S$ } See S. Whinery, Railroad Gazette Nov. 11, 1904. p. 537

W. C. Cushing
March 12, 1906.

DEDUCTIONS FROM TABLE II.

(5) With ties of inferior woods costing 46 cents delivered on the railroad we must obtain a life of from eighteen (18) to twenty (20) years, whether treated with zinc-choloride, zinc-tannin or zinc-creosote, to make them as economical as white oak ties costing 70 cents. It is assumed, of course, that they must have the most approved fastenings in order to attain an age as great as that.

(6) With inferior woods costing 46 cents delivered on the railroad, and if the creosoting costs 30 cents, it will be necessary for us to obtain a life of twenty-one

it will be necessary for them to last twenty-eight (28) years before they will be as economical as the white oak ties costing 70 cents delivered.

(10) With steel ties costing $2.50 delivered and concrete ties costing $2.25 delivered, which are approximately the prices of the Seitz steel tie and the Buehrer concrete tie, in the tracks at Emsworth, it is necessary for them to last over fifty (50) years each in order to make them as ecnomical as the white oak ties costing 70 cents delivered.

DEDUCTIONS FROM TABLE III.

(11) In order to make treated inferior woods as economical as white oak costing 70 cents delivered, when the

treated ties are equipped with proper fastenings in order to make them last as long as has been found practicable by experience, we can only afford to pay for the ties delivered on the railroad, 10 cents each when treated with zinc-chloride; 20 cents each when treated with zinc-tannin, or creosoted at 30 cents; 23 cents each when treated with zinc-creosote, and 29 cents each when creosoted in accordance with French practice.

(12) In order to make them as economical as white oak ties costing 70 cents delivered, we can only afford to pay $1.48 each for steel ties which last twenty (20) years, and $1.79 each when lasting thirty (30) years.

(13) In order to make them as economical as white oak ties costing 70 cents delivered, we can only afford to pay as first cost of concrete ties delivered, $1.15 each, if they last twenty (20) years, and $1.57 each if they last thirty (30) years.

(14) We know nothing about the life of concrete ties, and it is at least very desirable to experiment with them for yard and side tracks even though we do not use them in the main tracks, because they might lie undisturbed in yard tracks for many more years than they would in main tracks.

(15) When white oak ties are costing 70 cents delivered (about present prices), we can afford to buy inferior oak and other hard woods at 45 cents to 50 cents (present prices), and have them treated with the zinc-tannin or zinc-chloride processes, and only use common spike fastenings.

Table III. Showing first cost which can be paid for different kinds of ties in order to be as economical as white oak costing 70 cents and lasting 10 years.

Line	Letter of formulae	Description	White Oak untreated	Inferior Woods No Tie Plates		Inferior Woods with tie plates					Steel Lasting		Concrete Lasting	
				Zinc chloride	Zinc tannin	Zinc chloride	Zinc tannin	Zinc creosote	Creosote Lasting 16 yrs	Creosote Lasting 30 yrs	20 yrs	30 yrs	20 yrs	30 yrs
1		Assumed life of tie in years	10	10	10	12	14	16	16	30	20	30	20	30
2	i	" Rate of interest per cent	4	4	4	4	4	4	4	4	4	4	4	4
3	S	Annual Payt. for renewal (Kent p. 18)	.0833	.0833	.0833	.0665	.0547	.0458	.0458	.0178	.0336	.0178	.0336	.0178
4		Spacing Ties C to C in feet	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833	1.833
5		MAX. COST DELIVERED WHICH TIE CAN HAVE	.70	.48	.45	.10	.20	.23	.20	.25	1.48	1.79	1.15	1.57
6		Cost of treating tie		.15	.18	.15	.18	.27	.30	.85				
7		" " switching and foreign Frt.		.07	.07	.07	.07	.07	.07	.07	.06	.06		
8		" " putting in tie	.12	.12	.12	.12	.12	.12	.12	.12	.15	.15	.15	.15
9		" " 4 track spikes	.064	.064	.064									
10		" " 4 bolts									.10	.10	.16	.16
11		" " 4 wood screws				.15	.15	.15	.15	.15				
12		" " 4 helical linings				.03	.03	.03	.03	.03				
13		" " 2 tie plates				.32	.32	.32	.32	.32				
14		" " application of fastenings	.03	.03	.03	.12	.12	.12	.12	.12	.07	.07	.07	.07
15		Total cost of tie in track	.914											
16		Cost of ties per lin. ft. of track	.498											
17		Value of old ties per lin. ft. of track									.40	.40		
18	x	Annual cost of ties per lin. ft. track	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614	.0614
19		" " " " Mile	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19	324.19

Formulae $\begin{cases} x = C.i + (C-V)S \\ x = C(i+s) \end{cases}$ See S. Whinery Railroad Gazette Nov. 11, 1904 p 537

W. C. Cushing
March 12, 1906

Sink Holes

THE phenomenon of a right of way disappearing and leaving no vestige of ties or rails is not an occurrence calculated to produce peace of mind to those responsible for the maintenance of way, and there is probably no other visitation of Providence that can equal the trouble and expense to a railroad, that lies within the possibilities of a sink hole in proper working order.

Some of the most notable instances of the bottom falling out from under the tracks have occurred in Indiana which had earned a distinction all its own in this line, more than thirty years ago, and has right well sustained its claim to the front rank for losing track by this means. Subterranean streams or lakes are commonly the cause of such disturbances, but they have even been ascribed to seismic causes which, while they were supposed to be strong enough to allow considerable area to fill a void have not been felt on the surface.

In any event the amount of material necessary to bring up the bottomless area to grade is quite beyond comprehension. The Pan Handle road, when headed toward Chicago, found one of these spots with no bottom, and was able to proceed only after many trainloads of rock, earth and wood were sent into its yawning mouth. It is a peculiarity of these holes that when bottom has apparently been reached the same trouble will crop out at a point not far distant from the original one.

Modern Railway Coal Chutes

III.

CONCRETE STEEL COALING STATION AT SOUTH EASTON, PA., LEHIGH VALLEY RAILROAD.

THE conditions presenting themselves for the installation of a coaling station at this point on the Lehigh Valley Railroad formed an extremely difficult problem and required original treatment. For a better understanding of the difficulties, the following conditions are here given:

South Easton is perhaps the most congested point, in a traffic way, along the Lehigh Valley, and absolutely none of the then existing track room could be spared for the location of the new structure. On the north side of the main tracks was very valuable canal property and on the south side close to the tracks, was a high rock bluff.

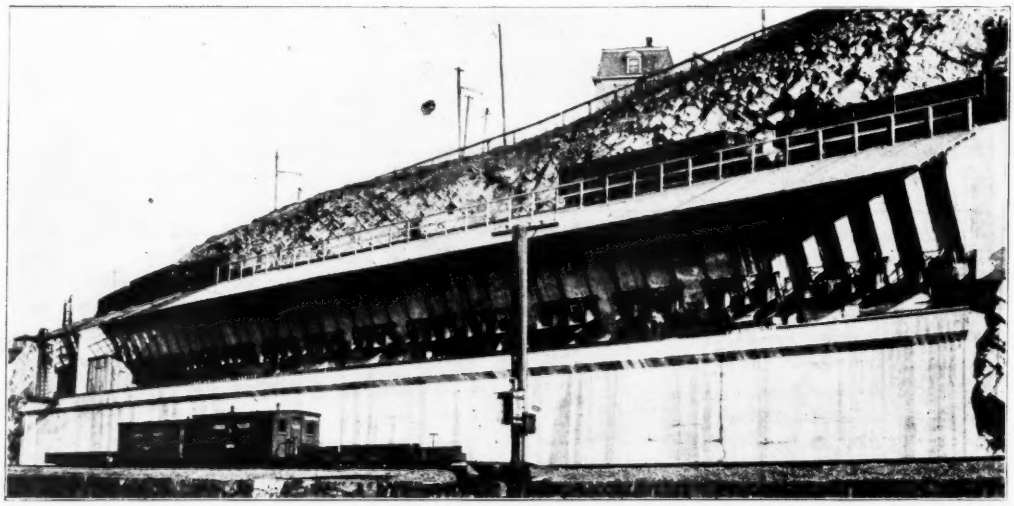
The principal need for the coaling plant was for the coaling of yard and house engines almost exclusively, about one hundred per day of 24 hours, but the arrangement of track crossovers was to be such as to permit of through freight engines in either direction, to cut off from their trains and take coal when necessary.

The high rock bluff on the south side of the tracks was agreed upon as the better plan of the two propositions mentioned previously, though it of course involved heavy cutting. In the excavation and removal of some 23,000 yards of limestone rock, the difficulties attendant, were considerable. As previously stated, traffic at this point was very heavy, and had to be maintained uninterruptedly throughout the progress of the work. All blasting operations required the utmost caution as the work was carried on within city limits.

In addition to the large amount of excavation necessary for the approach track, about 2,000 cubic yards of dry retaining walls had to be built, varying in height from four to twenty-two feet. Owing to the very limited space available for derricks, an old style hand wrecking crane or car, was rigged up with a small hoisting engine, and proved an invaluable aid within certain limits. Ninety per cent of the walls less than twelve feet high were built with this crane.

The natural pitch of the rock on which this structure rests, is, roughly speaking, at right angles to the line on which the foundation piers tend to slip, and so affords an almost perfect resistance to any such tendency and again this natural resistance is aided by the old scrap-rails placed in the rocks at the bottom and back of the piers to prevent overturning.

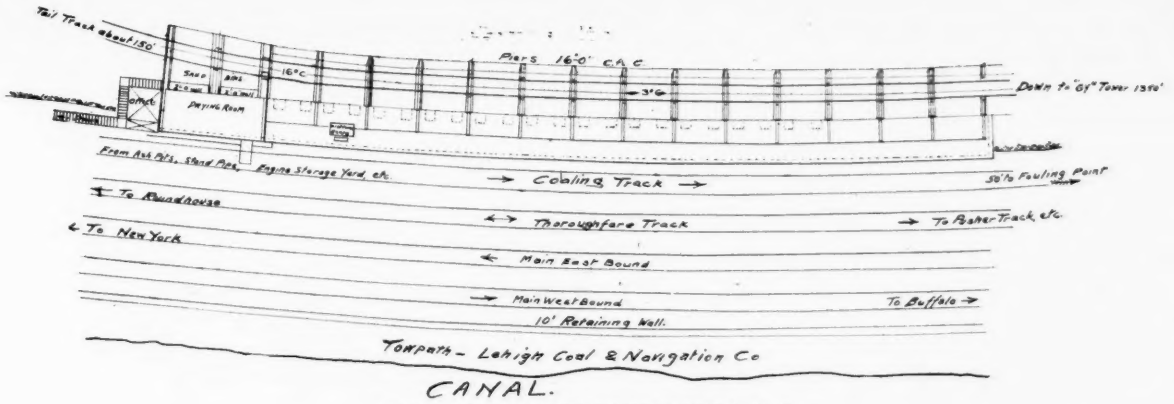
For the reinforcing of concrete used in the piers and the fronts of the pockets, about 7,000 feet of ⅝ inch Ransome twisted steel bars were used. The amount of concrete was close to 1,300 yards, the larger part of it being the Lehigh Valley standard mixture of 1-2-4.



LEHIGH VALLEY COALING STATION—SOUTH EATON, PA.

Provision was made in the original plan for the facing of the rough rocks at the back of the pockets, with concrete and also a drainage ditch, but as yet these have not been completed. Both will probably have to be done sooner or later as it is difficult to prevent seepage through the crevices in the rock later giving rise to a bad condition in the pockets. A shed for covering the pockets was also designed, but has not been built and may not be. The design calls for a combination wall and ditch at clearance height above the dumping track and built into the rock, one end of the joists resting on this wall, the other end on posts having their footings on the piers. This would probably obviate the necessity for a ditch at the track level.

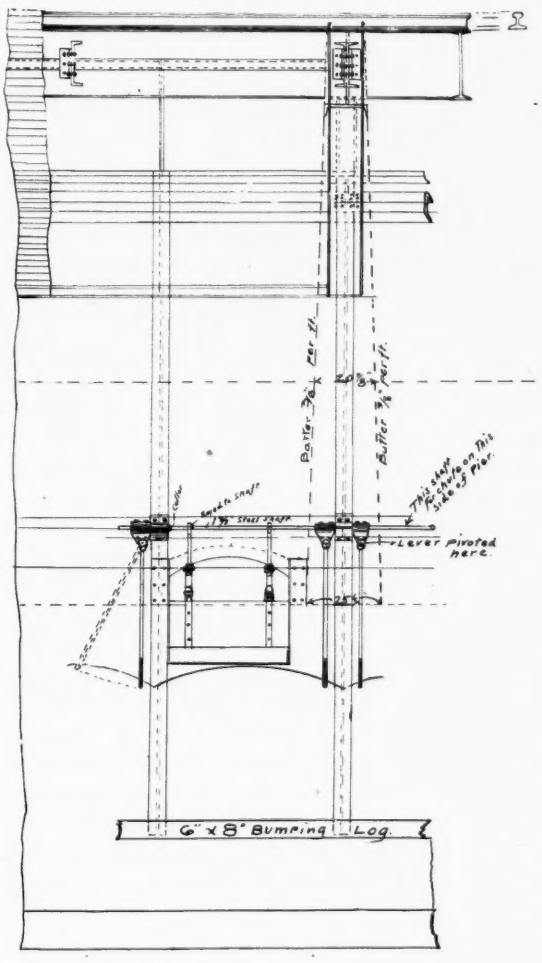
At one time it was intended to make the facing wall along the coaling track a series of twelve-foot arches in order to save concrete, and afford a place into which dirt, inseparable from such a place as this could be



LEHIGH VALLEY COALING STATION—GENERAL PLAN

shoveled, until a sufficient amount had accumulated to load up and haul away. This project was abandoned on account of the expense involved in the construction of forms for the arches.

After two or three months of blasting with 40% dynamite, "Jovite" of an equivalent strength was adopted as an explosive and gave very satisfactory results. After beginning the use of this agent, none of the "wild shooting," which occasioned considerable trouble when using dynamite, was experienced. The Jovite seemed to break the stone up in smaller pieces than dynamite did, without throwing the pieces around the country. This higher breaking power was no small item where nearly all the stone had to be moved by hand. The excavated material was used for rip-rapping bridge piers, and for lining the banks along the Lehigh Valley, a work in itself of great saving to the road.

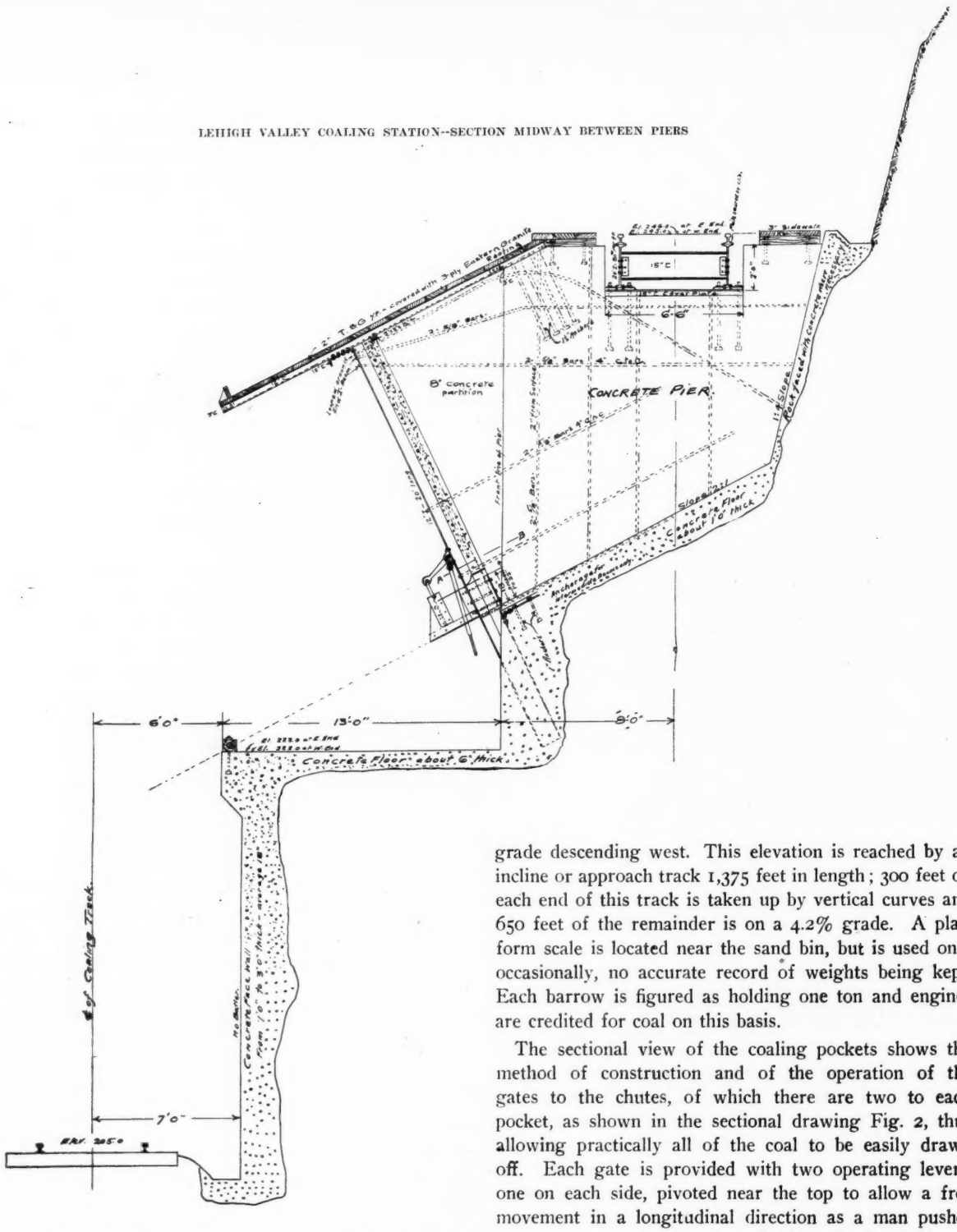


LEHIGH VALLEY COALING STATION—PARTIAL FRONT ELEVATION

Easton is a terminal for some classes of freight, and all passenger trains change engines there, while a large number of yard engines are used in the immediate vicinity. The passenger engines generally burn lump anthracite, while the freight and yard engines burn a mixture of small anthracite and bituminous in about equal parts. This question of mixing considerably more than half of the five or six hundred tons of coal used daily, decided the officials in favor of a platform type of plant rather than one in which the coal was dumped direct from pocket into tender. The plan adopted was to use one-ton carts, or barrows as shown in Fig. 1, and to dump alternate loads of anthracite and bituminous into the tenders. At the same time the pockets are so designed that for handling lump coal, which requires no mixing, any one of the chutes can be cheaply extended to reach out over the edge of the face-wall and to dump direct into the tender. The gates are operated by the fireman on the tender. Should the road permanently discontinue the policy of mixing coal, the present concrete front can be removed and a new front somewhat as shown for the sand bins, can be substituted. Thus they may secure approximately three times the present capacity, which is about seventy-five tons for each of the fourteen coal pockets. The double sand pocket has a storage capacity of about 850 tons of damp sand (a three months' supply), and is equipped with a steam drying plant of sufficient capacity to meet all demands.

In this connection attention is called to the sharpening of the curve over the sand bin, for the double purpose of giving increased capacity to the bin, and to throw the tracks away from the edge of the rock, which, due to some of its giving away, had to be cut back on a flatter slope than original figures required. On this sharp curve it was considered impractical to secure the rails

LEHIGH VALLEY COALING STATION--SECTION MIDWAY BETWEEN PIERS



to the beam girders with clips as elsewhere, and hence were set 7 inches deeper in the piers. Ties were used to carry the rails.

The dumping track on these pockets is from 40 to 41 feet above the engine coaling track and is up on a 0.4% grade descending west. This elevation is reached by an incline or approach track 1,375 feet in length; 300 feet on each end of this track is taken up by vertical curves and 650 feet of the remainder is on a 4.2% grade. A platform scale is located near the sand bin, but is used only occasionally, no accurate record of weights being kept. Each barrow is figured as holding one ton and engines are credited for coal on this basis.

The sectional view of the coaling pockets shows the method of construction and of the operation of the gates to the chutes, of which there are two to each pocket, as shown in the sectional drawing Fig. 2, thus allowing practically all of the coal to be easily drawn off. Each gate is provided with two operating levers, one on each side, pivoted near the top to allow a free movement in a longitudinal direction as a man pushes a cart along under the chute holding the lever in one hand.

We are indebted to Mr. W. E. Phelps, 57 Lake Shore Building, Cleveland, Ohio, for drawings, information, etc.

Air Resistance of Electric Railways

THE Electric Railway Test Commission which was named by the president of the Louisiana Purchase Exposition and Prof. W. E. Goldsborough, chief of the Department of Electricity, has formulated the results of its work, in some most valuable data on the very important phase of air resistance in electric car operation, which will be quite likely to force a radical change in the lines of cars engaged in high speed service.

The air resistance tests which are the only features of the report considered here, comprised the total train resistance, and also that referring to the air resistance of vestibules and car bodies. The total resistance was determined under different speeds, with the car operating in both directions, front and back; the cars used in the tests being an ordinary Interurban car and the special dynamometer car which was constructed especially for the purpose of experimental work, and having as a part of equipment, vestibules of various forms, by which the effect of the shape of vestibule was noted in the resistances. It was demonstrated that head end resistances from the ordinary flat vestibule for all speeds was four times that of the vestibule having the form of a parabolic wedge. At 60 miles an hour the unit pressure on the pointed vestibule was 2.1 pounds and on the flat vestibule, 8.2 pounds.

It was also found that the rear vestibule presented a resistance in the form of suction which aided retardation, this resistance amounting to as much as 16 horse power at 60 miles an hour when the flat vestibule was used, and demonstrating the necessity of a wedge form at the rear for high speeds.

The dynamometer car was run at various speeds up to 70 miles an hour, its four motor equipment having a capacity of 300 horse nominal horse power. In the hundreds of runs made with the different vestibules, the recorded pressures were accurate and afford the best of evidence that the shape of the vestibule is a very important factor at any speed, as was shown in the motor capacity, with which it was impossible to attain a speed greater than 60 miles an hour with the flat front, whereas, with the parabolic wedge front, 70 miles an hour was reached without trouble. The effect of these factors on the power as shown by carrying out a curve on the above basis for a speed of 100 miles an hour, means that 467 kilowatts would be required to overcome the air resistance alone of a flat ended car, while 175 kilowatts would do the same work when the car was equipped with the parabolic form of vestibule, which form is also a necessity for the rear as well when the suction per square foot varies from 0.1 pound at 20 miles an hour, to 1.0 pound at 60 miles an hour with the ordinary vestibule.

Head and rear end air resistances are the greatest as compared with those on the surface of the car-body. The average values of the body resistance was found to be 97.6 pounds at an average speed of 36.4 miles an hour. The mechanical means taken to obtain these results, and the care taken in the observations under the various conditions of test, preclude any question of accuracy. The general principles followed in the construction of the test car, was to support one vestibule in such a way that the air pressure could be measured by a dynamometer. Again, the entire car-body, including the vestibules was carried on bearings as nearly frictionless as possible, and the air resistance was measured by a second dynamometer. These tests while giving results of which only the vaguest knowledge was known here, and therefore are of the greatest value, have subordinate rolling and internal resistances to second place, but have given instead, definite lines for the construction of car ends, which should be sharp at the front end and a parabola at the rear, if it is desired to minimize air resistance Such construction means that a given motor equipment will have a higher potential with a given power installation, or, in other words the generating plant may be smaller for a given motor equipment, either of which propositions have too strong a bearing on the earning capacity of a road to be neglected.

The decreased resistance to traction by means of the pointed ends for electric service will no doubt cause some inquiries to be made as to its adaptability to steam roads, here the same as abroad, where it has been in use for several years, where locomotives so equipped have been derisively called wind-splitters, which they are in fact, as the smoke-box front is in the form of a cone, and the front of the cab is wedge shaped. This practice is regarded with favor by German and French engineers for steam service, and since the value of the pointed ends can now be demonstrated in dollars, there is a good opening for its adoption in steam service in this country.

An alteration of landscape occurred recently on the Stevenson extension of the Southern Railway at Shellmound, Tenn., in which a hill 75 feet high and 800 feet long was reduced to the surrounding level by means of a blast from 11,000 cans of powder and 150 cases of dynamite, at a cost of about $7,000 for explosives and labor of boring the hill for their application. The operation was successfully performed without injury to those engaged in the reduction of the elevation.

Three dangerous elements in subway operation are brought to mind by the recommendation of Chief Engineer Rice to the Rapid Transit Commission of New York, on the occasion of the recent fire in the bore. They were as follows: 1. No parts of cars in subway service should be constructed of inflammable material. 2. An adequate fire-line service should be installed throughout the whole subway so that water can be had at interior points. 3. Means should be provided for quickly removing smoke in the subway in such emergencies. Some people will wonder why these simple safeguards were not incorporated in the original equipment.

Floating Girders of the Ferok Bridge Madras Railway, Into Position

THE Ferok Bridge is situated on the Calicut-Cannanore Branch of the Madras Railway, and crosses the Ferok river, which is subject to tidal action, and attains a depth of over 50 feet in high flood, its current then being very swift.

The bridge consists of six spans 121 feet clear, and 130 feet from centre to centre of piers, which are each formed of a pair of cast-iron cylinders braced together by wrought-iron boxes filled with concrete; the cylinders are 9 feet in diameter above the river bed, increased to 12 feet in diameter below that to the rock, on which all are bedded, the change being effected by tapering pieces.

Each cylinder ring is 6 feet high and formed of six segments having internal flanges with faced and planed joints, and are fastened together by screw bolts, the joints being further caulked with iron rust cement.

The cylinders were floated into position and sunk between bamboo rafts, suitably anchored, by dredgings, the final bedding on rock being done by divers, after which they were filled with cement concrete.

The Whipple-Murphy girders are of through type, as shown by the full view photograph of the finished bridge; and are peculiar, inasmuch as the floor carries a public road as well as the railway at the same level.

The rails of flat footed section are bolted to longitudinal teak beams, secured to the wrought iron trough girders, supported at their ends by cross girders riveted to the main girders.

The floor consists of wrought-iron arched plates on which the road metal is laid with its top level with that of the rails.

On one side is a planked footway supported by cantilevers as shown.

The public road at each end of the bridge is closed by a gate when trains are due, these being worked in connection with suitable distant signals, and the gatemen in charge are warned by electric bells (worked by the Ferok Station Master) when to clear the bridge of carts, etc., and close the gates, the station being within sight of the bridge. The Kallai Bridge consists of three spans of similar type, with the same roadway, gates, etc.; the Malabar District Local Fund Board paid the extra cost required to fit these bridges for use as public roads.

These bridges are now in use for about 18 years, and no difficulty has been experienced in working the road traffic over them in complete safety.

The weight of ironwork per span is 184.66 tons, and the cost of the Ferok Bridge per lineal foot was Rs. 621.

At the time the writer was selected to finish this bridge and other works on the Calicut extension, the system to be employed in putting these girders into place had been arranged, and those of the first span put in place.

The method adopted was briefly as follows:—Each girder forming the side of a span was erected and riveted up behind its abutment, and then hung from timber trestle frames of the form shown in the photos; these were supported as free rollers, made of pieces of 5 inches round iron piles, the girder with its trestle being drawn by ropes and winches up to and over the span or spans completed, the front end of the girder projected beyond the supporting trestle, as shown, and when the trestle reached the end of the finished span (one as shown in Photo No. 3), two barges lashed together with whole timbers on which a 12-foot cylinder and packing to the required height was fixed, was floated under the trestle at about low water, and as the tide rose the girder end and trestle were raised.

The barges were previously sunk with water, which as occasion required was bailed out, so as to maintain the forward end of the girder at a suitable level.

To the end of the girder was fixed a rope from a crab winch placed on the second pier beyond, and ropes were also passed from the barges to winches placed on bamboo rafts beyond the next pier; by means of these ropes and winches the barges and girder were easily hauled across as shown in Photo No. 3.

As soon as the rear trestle reached the end of the finished span, the reserve barges with their cylinder and packing shown in the foreground of Photo No. 3, was towed round and placed under the rear end of the girder, which was raised thereby, after which the trestle was freed from it, and run back as shown in Photo No. 3; this done it was again hauled forward, and moved sideways till its ends were over their bearings, on to which it was finally lowered by a 60-ton hydraulic jack under each end.

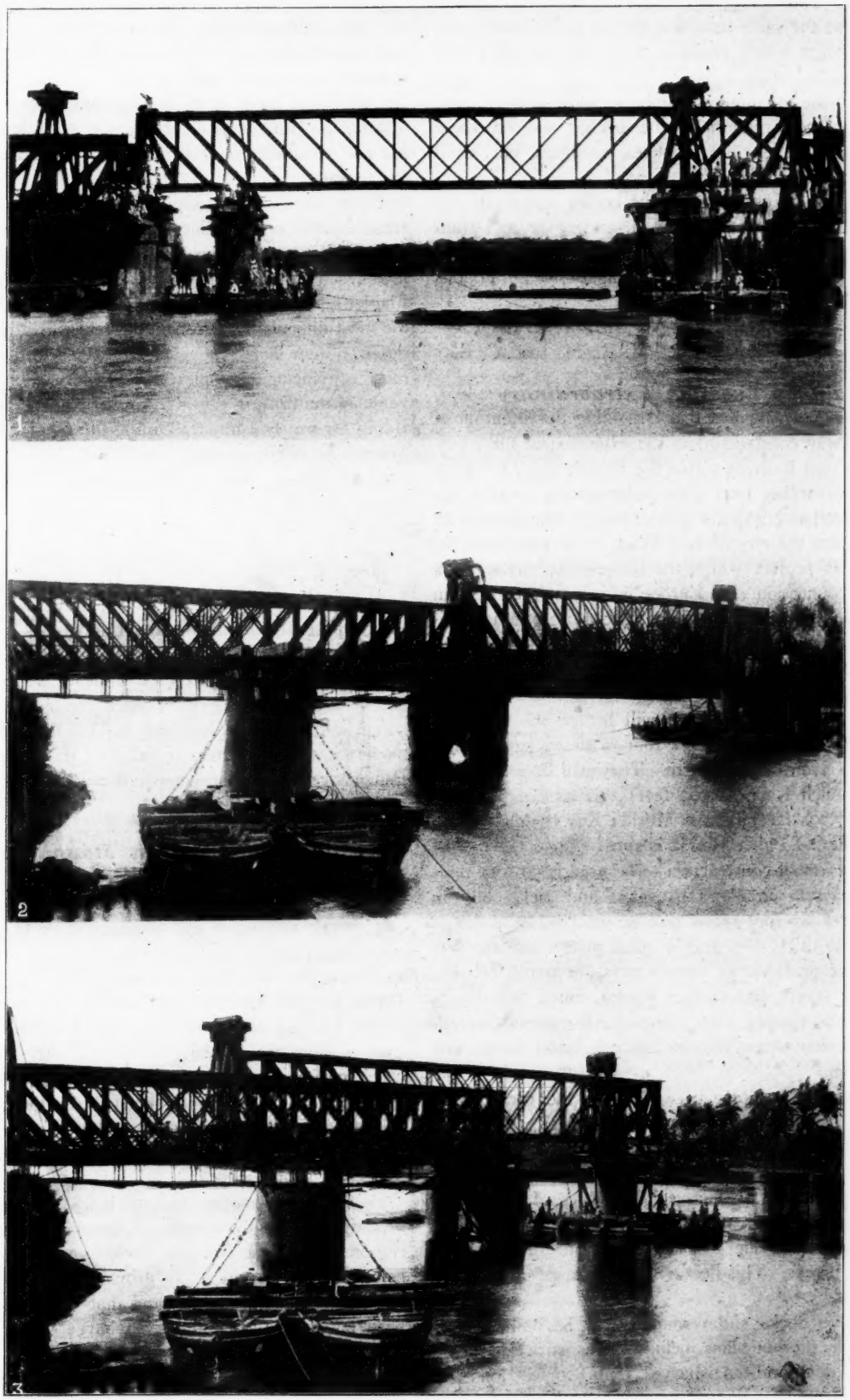
This was much the most difficult and arduous part of the entire operation, and required the greatest care to effect it safely.

It will be seen from Photo No. 2 that the forward end was still supported by its trestle, the rear being kept from turning over by raking struts whose feet rested against chocks bolted to the long transverse beams shown, and these struts had to be placed evenly and gradually as the girder was lowered by the jacks.

As soon as both girders were thus put in place and their ends fixed on their bearings, the floor cross girders and overhead bracing were put in place, service bolted, and riveted up; after which the channel rail beams, and flooring plates were put in place and riveted.

The entire work was done by local Moplah labour, among whom were a number of very strong and expert men, who had worked for several years on the construction of large girder bridges on the Madras Railway.

The photos clearly illustrate this rather novel work, a description of which will, it is hoped, be of interest to



FLOATING GIRDERS INTO POSITION, FEROK BRIDGE, CALICUT, CANNANORE BRANCH MADRAS RAILWAY

engineers. This bridge is notable as providing a public cart road at the same level and on the same floor as the rails; a design which might be frequently adopted with advantage.

Rafts made of hollow bamboos were largely used during the construction of the bridge and on these were placed the engines, winches, dredgers, etc., used in sinking the cylinders.

As the line on each side of the bridge was ready for opening before it was completed, an engine and train of carriages were taken across the river on bamboo rafts, getting the engine on to its raft being rather an anxious and novel experience for the writer.

E. W. STONEY, C. I. E.,
M. E., M. Inst. C. E.

Railway Location Extraordinary

AN engineering feat that is holding the attention of railway constructors is the extension of the Florida East Coast Railway across the Florida Keys by means of concrete arches over gaps aggregating nearly six miles, as well as fills of far greater magnitude, to effect an entrance into the city of Key West. The early completion of this project will make the utopian dream of a Western connection with Europe by way of the Aleutian Islands look like a stern reality. The project as now under contruction at the Keys is interestingly described by F. D. Blount in "The Technical World Magazine," Chicago, as follows:

The concrete-arch viaducts will be the most difficult part of the work. There are four of these, aggregating more than five miles in length. They will be from Long Key to Conch Key (10,500 feet); across Knights Key channel (7,300 feet); across Mosher Key channel (7,800 feet and across Bahia Honda channel (4,950 feet). The standard form of construction to be used is 50 foot reinforced concrete circular-arch spans and piers; but in some places 60 foot spans will be used. The water is from ten to thirty feet deep in most places, and the bottom is limestone, but as these waters are frequently disturbed by severe and sudden storms, much difficulty is looked for in placing the concrete. All material, including the broken stone for the concrete, must be shipped from Miami.

The floating equipment engaged in the construction work consists of six tugs, one stern-wheel steamer, 16 barges 25 by 100 feet, 24 barges 30 by 100 feet, 12 barges 20 by 80 feet, one sand dredge, one earth dredge for filling the concrete viaducts; eight barges 40 by 70 feet, with concrete mixers and hoists; eight pile drivers, eight towing launches, one dispatch-boat, four quarter-boats and 100 dingeys. This fleet will be increased as the work progresses.

Extensive docks and terminals will be built in Key West. The present plans include the construction of one large dry dock and ten wharves, each 800 feet long and 100 feet wide, with basins 200 feet wide between. The great piers will afford berths for forty boats 400 feet long. The depth of the water is from 20 to 40 feet.

With these harbor facilities, Key West will almost immediately rank with New Orleans, Mobile and Galveston as a commercial port. The importance of Key West as a southern naval base, and the weekly presence of the United States naval craft are in themselves a guaranty that the government will maintain a good depth of harbor and channels, allowing the entry of vessels drawing much water.

Three years is the time allowed for the completion and actual operation of rolling stock over the Key West extension. Engineers who have to deal with big problems in railroad building, and who have been informed of Mr. Flagler's plans, have unhesitatingly said that it is one of the most difficult feats to be undertaken by any transportation system in recent years. It will afford one of the most convincing examples in the entire country of the value of reinforced concrete construction. The idea of riding for nearly a hundred miles, the greater part of the journey almost in contact with water, while but a short distance away, foam-tossed combers of the Atlantic Ocean and the Gulf of Mexico can be seen from the car windows, is, in itself, sufficiently unique to attract passengers to the land of sunshine and flowers.

It has been said that E. H. Harriman regarded the Lucin cut-off across Great Salt Lake in Utah—built for the purpose of eliminating about 100 miles of track on the Union Pacific—as the monumental achievement of his life. Engineering experts, however, assert that the feat of bridging the Keys is a much greater one; and economic authoriteis declare that no similar enterprise of modern times, with the exception of the digging of the Panama canal, can be compared with it in commercial benefits to the United States.

Why the Charing Cross Station Roof Collapsed

THE failure of the roof of the Charing Cross station, which was noted and commented on in the February issue of *Railway Engineering*, has been investigated by Major J. W. Pringle, inspector of the Board of Trade, and the result of his inquisition into the causes of the rupture in the trussing seems to trace the collapse to faulty welding in a tie rod 4⅝ inches in diameter which performed the function of a chord. The disaster was hastened by a staging erected for the purpose of making repairs, the weight of which was said to stress the tie rod to an amount of about 0.2 more than the normal load of the roof.

From the information adduced it was concluded by the investigator that the weight of the staging was directly responsible for the fracture, the internal flaw in the rod being such as to ultimately provoke failure without the aid of an extraneous load, and that while due care had been taken by the engineer in charge of the roof, due weight was given to the fact that it was impossible by any practical means to have discovered the flaw.

The report also brought out the fact which is not new to anyone conversant with the first principles of the strength of materials, that the possibility of detecting an

interior flaw was very remote. This report will of course fail to throw any light on the weakness of the roof, or suggest any means of averting a like disaster on other ancient engineering monuments yet existent. There is no doubt that the proper method to demonstrate the weakness of that and other similar trusses, is to put the tension members to test to determine how near the dead load line they stand. That is the only way to detect a hidden flaw, or determine the ultimate strength of the member.

Temperature Conditions in Under-Ground Railways

THE New York subway engineers have evolved a plan for cooling the air in that bore, and its installation is now nearing the stage to give the experiment a trial. This scheme contemplates cooling the air by its contact with cool water forced through coils of piping. The air is drawn fresh from points above the street level, and forced by immense fans into the station after the cooling. Driven wells furnish the water supply, which is raised by pumps at the rate of 450 gallons per minute at each well. The temperature of the water coming from these wells is about 60 degrees when entering the cooling coils with which the air comes in contact, these coils each having a surface calculated to cool 75,000 cubic feet of air per minute, by which it is expected to reduce the temperature in the station about 15 degrees. If these experiments prove successful in the temperature tests, there is reason to look for a partial abatement at least, of the smells for which this subway has become famous, as dilution of the stagnant air by the fresher input should produce such ventilating effect.

"Temperature Conditions in Underground Railways" is the caption of an article in *The Engineering Magazine* for July, which is reproduced in this connection as follows:

"It is always well to endeavor to profit by the mistakes of predecessors, and it is interesting to note that in Germany the question of proper ventilation and cooling is being considered in connection with proposed tunnel railways, in view of the somewhat unexpected results which had developed in the New York subway and the Paris Metropolitan. In an article by Inspector H. Kayser, in a recent issue of the "Gesundheits Ingenieur" the whole subject is discussed in the light of American and European experiences, with suggestions for the abatement of the heat difficulty in connection with the proposed structures in Berlin.

There has existed a very general popular opinion that underground electric railways would be accompanied with a greater degree of uniformity in temperature than existed on the surface, being cooler in summer and not so cold in winter, this opinion being doubtless derived from the conditions existing in cellars and underground basements of buildings. Practical experiences, however, showed the fallacy of this opinion, since, in the heated summer weather in New York it appeared that the temperature in the subway was from 3.3 to 4.4 degrees centigrade higher than that of the outside atmosphere, and that similar results were obtained in Paris.

This apparently unexpected result is simply explained by the fact that a large part of the electric energy delivered to the motors on the trains is converted into heat. Not only the losses in the conversion, but all of the energy suppressed in bringing the trains to rest, is converted into heat, and unless some method is introduced for its dissipation, it not only appears as heat, but the heat is allowed to accumulate until the temperature is raised to a degree too high for comfort. This is true not only of the electrical energy but of all other forms of energy which are changed by the propulsion of trains through a tunnel against various resistances. Thus the rail friction, the atmospheric resistance, the brake friction, and every form of absorption of energy not otherwise accounted for must reappear as heat, and, in the absence of any special methods of dissipation, can only appear in the increased temperature of the contained mass of air.

The facts in such cases may be made to appear in a more concrete manner by the presentation of the subject in the way used by Inspector Kayser to give the natural result of the operative conditions. If, for example, the power house by which the electric energy is furnished consumes 500 tons of coal per day, and if only ten per cent of this energy reappears as heat through unavoidable losses in the tunnel, the heating effect will be the same as that which would be produced by the combination of fifty tons of coal per day in the tunnel, and devoted to the warming of the contained mass of air.

Inspector Kayser examines the computations which have appeared in some of the American technical journals regarding the actual amount of heat evolved in the New York subway, showing that this action is amply able to account for the difference in temperature between the air in the tunnel and that of the outside atmosphere, and he shows that the conditions in Paris confirm the results obtained in New York.

Since the rate of dissipation of heat in a tunnel has an important bearing upon the rate at which the temperature of the contained air increases, Inspector Kayser considers that nature of the soil through which the tunnel passes as an element in the problem. The subway in New York passes through a body of sand and rock which forms a very effective non-conducting jacket to the tunnel, so that the conduction of heat through the walls is comparatively slight, and hence the only way in which the excess of heat can be effectively removed is by convection with the movement of the air. In this connection the experience with the underground portion of the Berlin municipal railway extending to Charlottenburg is cited, showing, in winter weather, an increase of 4 to 5 degrees centigrade above that of the external air, while the surrounding earth showed a still higher temperature.

There appears to be no doubt that it is by a continual change of air that the heat is to be carried away from any such underground railway, and hence it should be a part of the original design of such a subway to provide for a determinate movement of the contained air by some artificial and controllable means.

Air which is intended to serve as a cooling medium should contain a proper amount of moisture, since this adds very greatly to its capacity for absorbing heat. Thus the evaporation of one cubic meter of water involves the absorption of 560,000 calories, an amount estimated equal to ten per cent. of the entire heat developed in the Berlin subway and there appears to be no difficulty whatever in the evaporation of a cubic meter of water over a length of four kilometres. The absorption of such an amount of water need not render the air uncomfortably moist, since the movement of the air required for ventilation would effect a change with sufficient rapidity to keep the atmosphere from approaching such a degree of saturation to produce discomfort. When a tunnel is driven through moist earth it is advisable to permit this ground water to maintain the interior of the tunnel in a moist condition, this providing an absorbent for a large portion of the heat.

The movement of the air in tube tunnels is largely effected by the motion of the trains, the cars so nearly filling the section of the tubes as to act almost like pistons. For tunnels of larger section, admitting two or four tracks, this action cannot be relied on, and some auxiliary system should be employed. When the tunnel is nearly level, probably the circulation of air will require the use of fans or other mechanical devices, but if the road includes ascending and descending grades it will be found possible to place ventilating shafts at the highest and lowest points, the warm air ascending through the highest shafts will produce down currents through the shorter ones and thus maintain a circulation without the use of machinery.

Personals

Mr. L. D. Lesseur has been appointed supervisor of roadway of the Western of Alabama.

Mr. G. H. Macdonough has resigned as signal engineer of the Cleveland Cincinnati Chicago & St. Louis.

Mr. J. S. McGuigan has resigned as roadmaster of the Missouri Pacific at St. Louis, Mo.

Mr. T. E. Parsons has been appointed resident engineer of the Mexican Central at the City of Mexico.

Mr. N. P. Turner has resigned as chief engineer and roadmaster of the Texas Southern and the office has been abolished.

Mr. J. H. Bowen, roadmaster of the Chicago Burlington & Quincy at Seneca, Neb., has been transferred to Sioux City, Ia.

Mr. T. J. Hardman has been appointed chief engineer of the Shreveport & Northeastern, under construction in Louisiana.

Mr. E. E. Colby, city engineer of Chickasha, I. T., has been appointed chief engineer of the Western Oklahoma, under construction.

Mr. H. J. Shaw has been appointed assistant engineer of the Pennsylvania lines, Northwest system, at Toledo, O., in place of Mr. Hugo Eichler, resigned.

Mr. F. A. Kell has been appointed roadmaster of the Mississippi River & Bonne Terre, with office at Bonne Terre, Mo., in place of Mr. E. B. Finnessey, resigned.

Mr. Joseph Ripley, formerly general superintendent of the Sault Ste. Marie canal, has been appointed principal assistant engineer of the Isthmian Canal Commission.

Mr. H. M. Robinson has been appointed division engineer of the western division of the Raleigh & Pamlico Sound, with headquarters at Raleigh, N. C.

Mr. A. Smith, roadmaster of the Missouri Pacific at Nevada, Mo., has been appointed roadmaster at Fort Smith, Kan., to succeed Mr. L. Mead, who is made roadmaster at Nevada.

Mr. George Sample has been appointed roadmaster of the Missouri Kansas & Texas at Denison, Tex., in place of Mr. C. Qualls, resigned.

Mr. W. Whitaker has been appointed acting roadmaster of the Norfolk & Western at Kenova, W. Va., in place of Mr. F. Walker, resigned.

Mr. E. S. Stevens, heretofore second assistant engineer of the Pittsburg division of the Baltimore & Ohio, has been appointed assistant division engineer at Connellsville, Pa., to succeed Mr. G. D. Swingley, promoted.

Mr. A. B. Griggs, heretofore engineer of maintenance of way of the Wheeling & Lake Erie at Canton, O., has been appointed division engineer at that point.

Mr. J. W. Beatty has been appointed chief engineer of the Denver Kansas & Gulf with headquarters at Medicine Lodge, Kan., to succeed Mr. B. J. Dalton, resigned; effective on Sept. 1.

Mr. G. D. Swingly, assistant division engineer of the Baltimore & Ohio at Connellsville, Pa., has been appointed division engineer of maintenance of way at that point, succeeding Mr. John Ware, resigned.

Mr. E. C. Burgess has been appointed acting engineer in charge of construction of the St. Louis Brownsville & Mexico, with headquarters at Corpus Christi, Tex., vice Mr. W. P. Homan, chief engineer, resigned.

Mr. George A. Ricker has been appointed acting chief engineer of the Pittsburg Binghamton & Eastern, and Mr. John G. Ullman has been appointed principal assistant engineer, both with headquarters at Canton, Pa.

Mr. F. C. Irvine, assistant engineer of the Cleveland & Marietta division of the Pennsylvania Lines, has been transferred to the real estate department as right of way engineer, a new office. The position heretofore held by Mr. Irvine has been abolished.

Mr. F. M. Edwards, resident engineer of the Southern at Chattanooga, Tenn., has been appointed engineer of maintenance of way at Birmingham, Ala., to succeed Mr. P. S. Fitzgerald, resigned to accept the position of chief engineer of the Pratt Laboratory of Atlanta, Ga.

Mr. W. S. Dawley has been appointed chief engineer of the Allegheny Improvement Company in full charge of location and construction, with office in the Security building, St. Louis, Mo. This company will build extensions of the Missouri & North Arkansas, successor to the St. Louis & North Arkansas.

Mr. Halbert P. Gillette, consulting engineer of New York and a member of the American Society of Civil Engineers, has been appointed engineer for the Washington Railroad Commission, and has gone to Olympia to begin the work of estimating the cost of reproducing all the railways in the state.

Mr. O. H. Crittenden heretofore resident engineer of the International & Great Northern, has been appointed superintendent of bridges, buildings and construction, with headquarters at Palestine, Tex., succeeding Mr. A. L. Bowers, who has resigned to engage in railroad construction business.

Mr. Guy Scott, engineer of maintenance of way of the Marietta division of the Pennsylvania Lines, has been appointed engineer of maintenance of way of the Richmond division, with headquarters at Richmond, Ind., to succeed Mr. Robert Ferriday, who has resigned to accept a position with the Cleveland Cincinnati Chicago & St. Louis.

Mr. F. G. Jonah, terminal engineer of the New Orleans Terminal Company, in charge of the engineering work at Chalmette, has assumed the duties of Mr. A. L. Phillips, assistant chief engineer, who has resigned to accept the position of chief engineer of the Oklahoma City Denver & Gulf, with headquarters at Oklahoma City, Okla.

Mr. J. M. Podmore first assistant engineer of the western division of the New York Central & Hudson River, has been appointed acting supervisor of track at Kingston, N. Y. Mr. P. S. Green has been appointed acting first assistant engineer of the western division at Buffalo, N. Y., to succeed Mr. Podmore. Mr. S. E. Armstrong has been appointed acting second assistant engineer of the western division at Buffalo in place of Mr. Green.

The following official announcement has been made by General Manager Trice of the International & Great Northern: Mr. A. L. Bowers having resigned, the office of superintendent of construction, bridges, buildings and water service is abolished and the building, bridges and water service departments are placed under the jurisdiction of Mr. O. H. Crittenden, resident engineer, headquarters at Palestine, Tex.; effective on August 1.

Mr. C. A. Morse, acting chief engineer of the Coast lines of the Atchinson, Topeka & Santa Fe, has been appointed chief engineer of the Atchinson, Topeka & Santa Fe proper, with headquarters at Topeka, Kan. to succeed Mr. W. B. Storey, Jr., who has been made chief engineer of the system. Mr. Morse formerly was assistant chief engineer at Topeka, and has been acting chief engineer of the Coast lines since Sept. 1, 1905. His appointment as chief engineer takes effect on September 1.

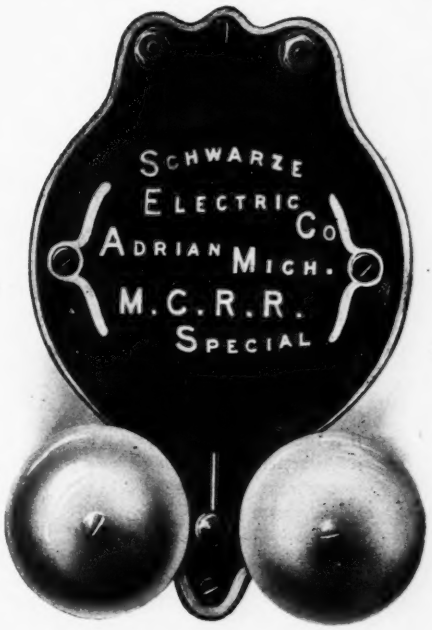
Mr. James Dun, chief engineer of the Atchinson, Topeka & Santa Fe Railway System, has been appointed consulting engineer, effective Sept. 1, and Mr. W. B. Storey, Jr., at present chief engineer of the A. T. & S. F. proper, has been appointed chief engineer of the system, with headquarters at Chicago, to succeed Mr. Dun. The latter was appointed chief engineer of the A. T. & S. F. in 1890, and has been chief engineer of the system since Aug. 1, 1900. Mr. Storey, from 1895 to 1900 was chief engineer and general superintendent of the San Francisco & San Joaquin Valley Railway, in charge of the construction of that line, which is now controlled by the A. T. & S. F. He was appointed chief engineer of the latter at Topeka, Kan., in 1900.

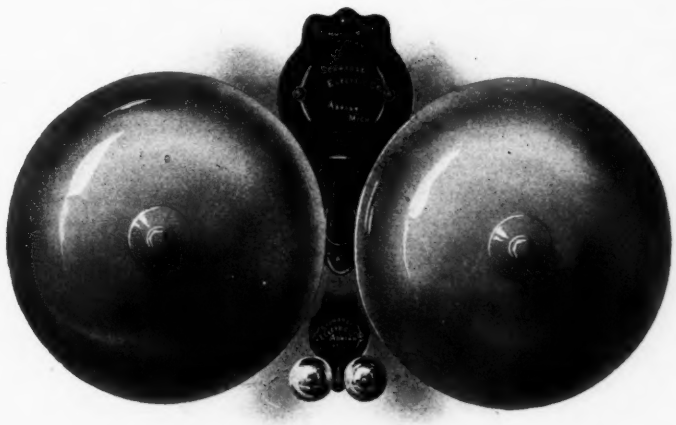
The columns of this paper are open at any time for discussion of minor matters pertaining to engineering and maintenance and especially to track work.

Expensive Railway Construction

The Manzanillo extension (of the Mexican Central Railway) will have a total length of 100 miles, and will cost $10,000,000 Mexican currency, or an average of $100,000 a mile. That part of the extension between Tuxpan and the City of Colima, capital of the state of that name will constitute one of the heaviest and most remarkable pieces of railroad construction on the continent. A spectacular feature is the fact that for the entire distance, forty-two miles, it will be almost in the shadow of the Colima volcano, the only continuously active volcano in North America. As the crow flies, the volcano is from ten to twenty miles distant from the route of the railroad. Between Colima and Manzanillo the construction will be comparatively easy, as the standard gauge line will follow, for the most part, the route of the narrow gauge road connecting the port and the Colima capital. This railroad was built by Gen. W. J. Palmer twenty years ago, and was planned to form a link in the Mexican National railroad system. The Sierra Madre stopped it at Colima. The road was purchased by the Mexican Central interests last year.

Just below Tuxpan, in the southern part of the state of Jalisco, the Sierra Madre breaks into a series of barrancas, or great canons, hundreds of feet wide, hundreds of feet deep, grandly rugged, scenically magnificent. Along one of these barrancas, which cradles in its depths the Tuxpan river and drains the great peaks and table lands on either side, the route of the extension has been located. Civil engineers scrambling along perilous ledges, swinging from ropes along perpendicular walls, consumed three years in making the location, and, with a fall of nearly 2,500 feet from Tuxpan to Colima, succeeded in securing a maximum grade of two per cent. In the accomplishment of this task outlined by the engineers, the handiwork of nature is being destroyed. Mountains are being blown to pieces, men are boring tunnels through solid rock, massive abutments are being reared for the great steel bridges that will span the canons. The plans call for thirteen tunnels and thirteen bridges between Tuxpan and Colima. One bridge will have a height of 280 feet, making it the highest railroad bridge in Mexico and one of the highest in the world. There is one mile of the extension that will cost over $300,000, and several miles that will cost over $150,000 each. —The Tradesman.





Schwarze Electric Signal Bells

The repeated successes of the Schwarze Electric Bells is in keeping with the high grade type of work put out by the Schwarze people. One of their most successful installations is the No. 10 electric warning for the approach of teams that is working with a high degree of satisfaction on the Michigan Central R. R. The telegraphic department of this road has 21 of this No. 10 style in operation between Detroit and West Detroit stations. These are located in series at the houses of gatemen at street crossings, interlocking towers, switch-tender houses, and at depot platform, baggage-room, mail-room, etc., to announce to employees interested the approach or departure of trains. This bell wound to 100 ohms is also being used by the signaling department of the above road in connection with their switch indicator system to announce the approach of a train to a block. If there is more than one switch in the block a bell is placed on each and connected in parallel. By using this in such a manner, the apparatus announces the approach of a train to a block whether or not the train is occupying that block.

Such an arrangement is invaluable to smaller switching yards where lack of track would compel the switch engine to use the main line. Much valuable time is lost by the ordinary way as switch engines are ordered to clear the main line from 10 to 15 minutes ahead of arriving time of any train. The new Schwarze signaling tower for highways crossings in railway work is worthy of close investigation. For further information as to details, price, etc., address The Schwarze Electric Co., Adrian, Mich.—Chicago office, 324 Dearborn St.

Hardening of Hydraulic Cements

The main phases of the hardening process of hydraulic cements are due to the gradual giving off of the swelling-water, the progressing hardening of the colloids, the gradual hydration of the celite constituents, especially of the calcium ferrites of the celite, and, with Portland cement, in addition to the former causes also to the continued formation of crystals of calcium hydrate.

The gelatinous calcium-hydro-silicates and calcium-hydro-aluminates (not all of the hydro-aluminates crystallize) possess the peculiarity of being perfectly water-proof, and therefore we find the inside of all the larger grains of cement in an unhydrated state. covered with a gelatinous film. This fact I demonstrated thirty years ago by pulverizing a neat cement briquette, which had hardened in water for many years. Such re-pulverized cements harden again, and the strength which they obtain is the higher, the coarser the original cement has been. Le Chatelier has observed the same with calcium aluminate.

From the preceding it may be seen that the hardening process of hydraulic cements is not exclusively a chemical process, and that all investigators must be mistaken who maintain that the hardening is merely a process of crystallization from over-saturated solutions and of interlocking of needle-shaped crystals as with gypsum.

The hardening process is a combined action of colloids and crystalloids. The hardened cements contain: Water of constitution, water of crystallization, and water of colloids. The colloid-water causes much difficulty in the application of cements; it compels us to use lean mortars in order to avoid decrease of volume.—Dr. W. Michaelis, in Cement and Engineering News.

It is given out that the Grand Trunk has authorized the expenditure of $15,000,000 for betterment of equipment, to be paid for by the issue of four per cent debenture stock on the road; the expenditure to extend over a period of two years.

The Argentine Central Railroad, from Silver Plume on the Colorado and Southern, to the summit of Mount McClellan on Gray's Peak, was opened for traffic on August 1. This road reaches a point 14,000 feet above sea level and is the highest traction line in the world excepting only the Peruvian Central in the Andes Mountains.

And now it is the Philadelphia and Reading that is considering electrification of their immense suburban traffic out of Philadelphia, which requires five hundred trains per day to care for the suburban travel leaving and arriving at the Reading Terminal. and this is no doubt the heaviest travel of the kind in the East. The West Jersey and Seashore branch of the Pennsylvania road which inaugurated its electric service from Camden to Atlantic City, 59 miles, on July 1st., is giving a perfect service.

Among the new railway shops now under way, or contemplated, are the following: The Illinois Central has begun the erection of a new freight car shop 120x574 ft. at Burnside, Ill. The Oregon Railroad & Navigation Co., has commenced work on new shops and roundhouse at La Grande, Ore., to cost about $200,000. The Nicola Building Co., Pittsburg, Pa., is building a large power house, machine shop and office building for the Pittsburg & Lake Erie at Pollock, Pa. The Atchinson, Topeka & Santa Fe will build additional repair shops at Topeka, Kas. The Baltimore & Ohio has received bids for shops and a 25-stall roundhouse in connection with the new Washington, D. C., terminal. The Cleveland, Cincinnati, Chicago & St. Louis will, it is said, expend about $450,000 on the enlargement of its shops at Bellefontaine, O. The Atchinson, Topeka & Santa Fe will expend about $250,000 on exxtensions to its shops at Albuquerque, N. M. The shops of the St. Louis, Rocky Mountain & Pacific are to be located at Cimarron, N. M. The Kansas City Southern will make considerable improvements to its shops at Pittsburg, Kas.

Miscellany

We have received a copy of catalogue N. 69, issued by The Watson-Stillman Co., New York, manufacturers of hydraulic tools of all kinds. This catalogue is a selection of sheets from over 800 pages of printed matter, and especially relates to hydraulic tools for steam and street railroads. It illustrates and describes the various hydraulic jacks, punches, railbenders, crank pin presses, wheel and other presses, testing pumps, etc. Copies of any of these sheets can be had upon application to the company.

The Pilling Air Engine Company, Detroit, Mich., is about to issue a very interesting booklet which they herald in the following unique manner:—"Look out for the Pilling 'Mule.' It is a coming event whose reflections will be illustrated in swell pamphlet form sometime during the month of September, by the Pilling Air Engine Company of Detroit."

The firm of H. F. Vogel & Co., 420 Rialto Building, St. Louis, Mo., has been organized to engage in a general railway supply business. The organizers of the company are Mr. H. F. Vogel, who was formerly vice-president and general manager of the St. Louis Car Co., and Mr. Nic Le Grand, formerly manager of the supply department of the same company.

A novel scheme for putting out samples of roofing is that of the manufacturers of Paroid and Neponset Roofings. They have put in their dealers' stores door mats made of the Pariod Roofing itself, and it is a good way to prove the toughness and durability of Pariod. Samples of Neponset are put out in the shape of a cone shaped cup and the directions on the outside read: "Fill this cup with water and you will see that the water evaporates but never soaks through Neponset." Any one interested in roofing should send to F. W. Bird & Son, East Walpole, Mass., and ask for their samples.

The Link Belt Company is the new name of the Link Belt Machinery Company, of Chicago, which has purchased the plants and all other assets of its associate companies, the Link-Belt Engineering Company, of Philadelphia, and the Ewart Manufacturing Company, of Indianapolis. The company was organized in 1880 to manufacture labor-saving appliances,—employing the products of the Ewart Manufacturing Company. In 1882 a branch office was organized in New York, and in 1888 this branch of the business had grown to such an extent that it became necessary to have a manufacturing plant in the east, and in that year the Link-Belt Engineering Company, of Philadelphia, was organized. The new company will continue the manufacturing of conveying, elevating and transmission machinery, malleable and machine-made driving chains, etc. It has plants in Chicago, Indianapolis, and Philadelphia. Its officers are: chairman of the board, James M. Dodge, Philadelphia; pres., Charles Piez, Philadelphia; first vice-pres., Glenn G. Howe, Indianapolis; second vice-pres., Staunton B. Peck, Chicago; treas., S. Howard Smith, Philadelphia; asst. treas., P. G. Reid, Philadelphia; secy., Dyke Williams, Chicago; asst. secy., Edward H. Burr, Philadelphia.

The Quincy, Manchester, Sargent Co., Chicago, Ill., announces the opening of its Priest snow flanger department. Orders have already been booked this season for Canada, Japan, Mexico and Europe.

The General Railway Signal Co., Buffalo, N. Y., has been awarded the contract for the complete automatic block signaling of the Nankai Railway of Japan, which is the first high speed railway in Japan to be operated by electricity. The signal system to be installed is to be the same as is being installed in the electric zone of the New York Central, and the New York, New Haven & Hartford, and other high speed electric lines.